TITLE

"Growth and productive behaviour of *Rauwolfia serpentina* (L.) Benth. ex Kurz in soil ameliorated by coal fly ash."

INTRODUCTION

Huge amount of energy is needed to meet the increasing demands and as a result large numbers of byproducts are generated during energy production, which causes air, water and soil pollution. In an estimate the annual production of fly ash generated from thermal power plants during combustion of coal is around 112 million tons in India and is likely to increase 225 million tons by 2017 (Lokeshppa *et al.* 2011). Disposal of such fly ash in huge quantity is a great problem because at present there are no large scale recycling options available in our country.

Fly ash is an amorphous mixture of ferroaluminosilicate minerals generated from combustion of ground or powered coal at temperature ranging from 400-1500 ^{0}C. Physically fly ash occurs as a very fine particles having an average diameter of <10 µm, high surface area and light texture. Fly ash addition alters the physical properties of soil such as texture, bulk density, water holding capacity, particle size distribution. Chemically 95-99% fly ash is composed of Si, Al, Fe, Ca, Mg, Na, K with Si and Al forming the major matrix. Fly ash are classified into two types, Class F (having low lime) Class C (having high lime) based on total amount of Si, Al, Fe oxide. Fly ash is rich in trace elements like Hg, Co, Cr, B, Ca, etc. The variation in the concentration of elements depending on partial size is related to combustion condition, chemical and physical properties of the parent coal. Thus fly ash is proved to be useful byproducts which can be reused in different ways for economic and environmental benefits.

Fly ash which is produced in bulk during energy generation is causing serious problem for health. There is no well developed low cost and less time consuming technology available for the successful management of fly ash. Hence; it is the need of the hour to look for a technology which will be useful in management of fly ash in beneficial way. As the fly ash is highly enriched with the nutrients, it can be used in soil amelioration for the betterment of plants. It also influences the various physiological mechanisms like germination, growth, survival and reproduction, which can help us to understand the functional significance of specific plant traits and their evolutionary heritage.

On the other hand the agricultural practices in India are changing rapidly. Now the field is open for new experiments and techniques. Most of the industrial wastes or byproducts may act as pollutants, yet some of them may be used profitable in agriculture provided that they are used scientifically and judiciously (Raman *et al.* 1997).

In recent times, the awareness has been increased especially in the field of medicinal plants as people are returning towards the natural products. Many of the useful medicinal plants are becoming endangered. The healthy propagation of such plants is challenge for scientists. In that respect an endangered plant is selected for propagation in soil ameliorated with fly ash. This way management of fly ash could be done in soil amelioration and simultaneously propagation efficiency could also be increased. Looking to this fact *Rauwolfia serpentina* (L.) Benth. ex Kurz also known as Sarpgandha belongs to family Apocynaceae is selected for the study. It is one of the most important plants used as traditional medicine. Extracts of *Rauwolfia* plants have been used to treat several diseases. The pharmaceutical properties are mainly due to alkaloids, which have been extensively used as active ingredients in pharmaceutical preparations (Katzung 1994). *Rauwolfia* plant contains various alkaloids, ajmalicine, ajmaline, ajmalinine, chandrine, rauwolfine, reserpine, resrpiline, reserpinine, sarpagine, serpentine etc. therefore; it is used in treatment of various disorders such as hypertension, psychological disorder, anxiety, irritability, snake bite, fever, stomach pain, vomiting, and blood pressure (Dewick 2002).

In light of above knowledge the present research work is planned to analyze the impact of different fly ash levels incorporation to soil on soil properties and on growth and productive behavior of *Rauwolfia serpentina* (L.) Benth. ex Kurz.

A BRIEF REVIEW OF THE WORK ALREADY DONE IN THE FIELD

Many investigations related to the topic has been done so far in India and abroad .A brief review of the work has been mentioned here.

Soil amendment through Fly ash has been investigated by workers like Kumar *et al.* (2000), Gupta *et al.* (2002) and Jala *et al.* (2006). Properties of fly ash was studied by the workers like Kumar *et al.* (1998), Gangloff *et al.* (2000) and Kumar *et al.* (2000).Various studies had been done all over the world in few decades to determine the potential of fly ash as soil amendment, physiochemical changes in soil and its impact on several crop plants by Summers *et al.* (1998), Zhang *et al.* (2004) and Jaramillo-Lopez *et al.* (2011) in abroad.

Similar studies in India was done by Singh *et al.* (1994), Karla *et al.* (1997), Khan *et al.* (1997), Sharma *et al.* (2001), Mittra *et al.* (2005), Yunusa *et al.* (2006), Mishra *et al.* (2007), Shrivastava *et al.* (2008) and Punjwani *et al.* (2011).

Fly ash incorporation improves physical and chemical properties of soil. Fly ash is comprised primarily of fine particles, therefore, if applied at sufficient quantity, it can be used to change soil texture was investigated by Gangloff *et al.* (2000). Fly ash produced in different thermal power plants has difference in its properties like texture, mineral content, colour, pH. These properties were determined by Ansari *et al.* (2011). Mishra *et al.* (2005) found that fly ash amendments in soil caused a gradual decrease in sand content but increase in clay content. Fly ash addition was reported to alter the texture of sandy and clay soils to loamy soils it was studied by Karla *et al.* (2003), Mittra *et al.* (2003) and Pathan *et al.* (2003).

Considerable studies have been done in various parts of world to evaluate physical properties of soil such as texture, bulk density, particle size distribution, particle density, porosity and water holding capacity. These properties in soil ameliorated with fly ash was investigated by the workers like Clark *et al.* (1995), Gangloff *et al.* (2000) and Zhang *et al.* (2004) in abroad. Similarly by Singh *et al.* (1994), Arshad *et al.* (1996), Kumar *et al.* (2000), Mittra *et al.* (2003), Gupta *et al.* (2006), Mishra *et al.* (2007) and Punjwani *et al.* (2011) in India. Fly ash incorporation at sufficient rates may yield beneficial effects on water holding capacity of the soil was investigated by Brady *et al.* (1996). The addition of fly ash to soil shows an increase in water holding capacity and plant available water (PAW) was observed by Gangloff *et al.* (2000). Fly ash treated soil showed increased water holding capacity due to change in particle size distribution and an increase in porosity was studied in abroad by Gangloff *et. al.* (2000) and in India similar studies were done by Khan *et al.* (1997), Pathan *et al.* (2001) and Mishra *et al.* (2007).

Fly ash addition in soil significantly increases the electrical conductivity of soil by increasing the levels of soluble major and minor inorganic constituents. The pH exhibited an inverse relationship with electrical conductivity and total dissolved salts were studied by Kalra *et al.* (2000), Singh *et al.* (2000) and Gupta *et al.* (2007). Gupta *et al.* (2006) revealed that the mobility and plant availability of metal (Fe, Mn, Zn, Ni) within the profiles of fly ash amended soil. Mittra *et al.* (2005) and Gupta *et al.* (2006) observed fly ash alleviates the condition of nutrient deficiency in soil and improves physicochemical properties of soil, thereby increasing plant growth. Various scientists in abroad had studied the chemical

changes occurred in soil like pH, electrical conductivity, concentration of various elements after addition of fly ash like Clark *et al.* (1995) and Cline *et al.* (2000). Similar studies in India was done by Khan *et al.* (1996), Vijayan *et al.* (1999), Kalra *et al.* (2000), Pathan *et al.* (2004), Yunusa *et al.* (2006), Mishra *et al.* (2007) and Punjwani *et al.* (2011).

Fly ash addition generally showed positive impact on plant biomass production and nutrient uptake. In abroad it was studied by Sale *et al.* (1996). Similar studies in India were conducted by Mishra *et al.* (2005), Gupta *et al.* (2006) and Gupta *et al.* (2007). Mishra *et al.* (2007) proved that lower concentration of fly ash increased chlorophyll a and b and plant height. Different levels of fly ash affect the yield of seed in various crop plants. Fly ash effect on seed physiology was studied by Jaramillo-Lopez *et al.* (2011) in abroad. In India similar studies were carried out by Karla *et al.* (2003), Mishra *et al.* (2007), Shrivastava *et al.* (2008) and Punjwani *et al.* (2011). Various scientists studied the effect of fly ash on photosynthetic pigments like Rai *et al.* (2004), Mishra *et al.* (2005), Sinha *et al.* (2005), Dwivedi *et al.* (2007), Gupta *et al.* (2007) and Mishra *et al.* (2007). Majority of work had been done on crop plants to determine the effect of fly ash incorporation to soil and its responses on germination percentage, growth and productive behaviour, yield of plants on wheat, corn, soyabean, tomato, rye, maize, rice, gram under pot culture, green house and field study by workers in abroad like Cline *et al.* (2000) and Jaramillo-Lopez *et al.* (2011). Similarly in India by Sharma *et al.* (2001), Kumar *et al.* (2003), Gupta *et al.* (2006), Yanusa *et al.* (2006), Mishra *et al.* (2007) and Punjwani *et al.* (2011).

Majority of work had been done in crop plant world widely to find the effect of fly ash amelioration in soil and their effect on the growth and productive behaviour of the plants but the work on medicinal plant and their behavior on fly ash are very few. *Rauwolfia serpentina* (L.) Benth. ex Kurz exerted a beneficial effect upon anxiety, tension, worry and irritability, and have come to be popularly known as “transquilizing” drug. It is also used as antidote to snake bite and used in stomach pain, fever, vomiting, blood pressure, control nerve impulse and headache as reported by Dewick (2002). Various findings shows that *Rauwolfia serpentina* (L.) Benth. ex Kurz contains alkaloids like ajmaline, rauwolfine, reserpine, reserpinine, sarpagine, serpentine, serpentinine etc. Two major classes of alkaloids can be indentified in plant: reserpine-like and yohimbine-like indole alkaloids. Reserpine and rescinnamine are the two principle components of the reserpine class, and are known to have potent transquilizer sedative and antihypertensive actions.

OBJECTIVES

The present research proposal is designed to find out the feasibility of coal fly ash on amelioration of physico-chemical properties of soil and on growth responses, production behaviour of *Rauwolfia serpentina* (L.) Benth. ex Kurz under pot culture. The proposed work will be conducted to achieve following objectives:

1. To determine the potential of various concentration of coal fly ash to affect the physical as well as chemical properties of soil.
2. To find out the impact of fly ash on seed germination and growth responses of *Rauwolfia serpentina* (L.) Benth. ex Kurz under pot culture conditions.
3. To assess the impact of fly ash incorporation on medicinal value of *Rauwolfia serpentina* (L.) Benth. ex Kurz.
4. To evaluate the productive behaviour of *Rauwolfia serpentina* (L.) Benth. ex Kurz in pot culture under the influence of fly ash incorporated soil.
5. To determine the suitable concentration of fly ash for obtaining optimum level of seed germination (%) and vigour index in harvested seeds of *Rauwolfia serpentina* (L.) Benth. ex Kurz.
6. To estimate the suitable concentration of fly ash for obtaining optimum level of the growth, production behaviour and yield of *Rauwolfia serpentina* (L.) Benth. ex Kurz.

NOTEWORTHY CONTRIBUTION IN THE FIELD OF PROPOSED WORK

The noteworthy contributions have been made by many of the Indian and foreign workers in this field. Some of the noteworthy contributions made by Indian workers like Singh *et al.* (1994), Karla *et al.* (1997), Khan *et al.* (1997), Kumar *et al.* (1998), Vijayan *et al.* (1999), Kumar *et al.* (2001), Sharma *et al.* (2001), Gupta *et al.* (2002), Pathan *et al.* (2003), Rai *et al.* (2004), Jala *et al.* (2005), Mittra *et al.* (2005), Yunusa *et al.* (2006), Mishra *et. al.* (2007), Shrivastava *et. al.* (2008) and Punjwani *et. al.* (2011).

Similarly in abroad contributions made by the workers like Clark *et al.* (1995), Sale *et al.* (1996), Summers *et. al.* (1998), Cline *et. al.* (2000), Gangloff *et. al.* (2000), Zhang *et. al.* (2004) and Jaramillo-Lopez *et. al.* (2011).

PROPOSED METHODOLOGY

Plan of the work

Pot culture experiments with three replicates will be conducted to evaluate the impact of various levels of fly ash incorporation to soil on physico-chemical properties of soil and ecophysiology of *Rauwolfia serpentina* (L.) Benth. ex Kurz.

Physico-chemical analysis of soil sample

Physical and chemical properties like texture, hydrogen ion concentration (pH), electrical conductivity, total dissolved salts, porosity (%) , soil solids (%), bulk density, particle density and water holding capacity (WHC) will be estimated by following the methods of Misra *et al.* (1970), Palmer *et al.* (1977), APHA, AWWA and WEF (1992), Blake *et al.* (1986 - a, b) and Pandeya *et al.* (1968) respectively.

Physiological studies of *Rauwolfia serpentine*

Physiology of *Rauwolfia serpentina* (L.) Benth. ex Kurz will be evaluated by analyzing following parameters:-

Characteristics of seeds

In present investigation, characters of seeds viz. moisture content, rate of germination, mean daily germination (MDG), peak value (PV), germination index (GI), average seedling length (in cm), average seedling dry weight (in gm) and vigor index (VI) of *Rauwolfia serpentina* (L.) Benth. ex Kurz will be assessed.

Characteristics of plants

1. Plant characteristics like Root length; shoot length, number of leaves per plants, leaf area per leaf, leaf area per plant, number of branches of *Rauwolfia serpentina* (L.) Benth. ex Kurz will be measured.

2. Photosynthetic pigments Chlorophyll a, Chlorophyll b and Carotenoid contents of the plant will be determined by following the methods of Arnon (1949) and Duxbury *et al.* (1956).

3. Dry biomass of root, shoot and plant, moisture content (%) of the plant material will be determined.

Characteristics of medicinal values

Medicinal values of plant will be estimated by assessing the flavonoid, total phenol and total alkaloid following the methods of Chang *et al.* (2002), Swain *et al.* (1959), Shamsa *et al.* (2008) respectively.

Characteristics of harvested seeds

Average number of fruit per plant, number of seeds per fruit, seed output per plant, seed yield per plant (gm), 1000 grain weight (gm), average seed germination (%), average seedling length (in cm), average dry weight of seedling (in gm) and vigour index of the *Rauwolfia serpentina* (L.) Benth. ex Kurz will be estimated.

Statistical analysis

Statistical analysis will be done to find out the significant correlations amongst the data collected from experiments.

EXPECTED OUTCOME OF THE PROPOSED WORK

1. The hazardous fly ash can be managed by the utilization of fly ash as soil conditioner.
2. Soil quality including physical and chemical properties could be determined before and after the amelioration of soil by fly ash.
3. Quantity of fly ash required for soil amelioration could be determined.
4. Ecophysiology viz. germination, growth, productive response, yield etc. of *Rauwolfia serpentina* (L.) Benth. ex Kurz in fly ash ameliorated soil could be understood properly..
5. The outcome of the proposed work will be helpful in planning fly ash management strategy for future.
6. Suggestion could be made to cultivators for the utilization of fly ash as a cheaper and potent source of nutrients.
7. The outcome of proposed work will be useful in analyzing the positive and negative impact of fly ash on soil characteristics and physiology of plant.

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